

Nutrient Pollution:

Current National Ocean Service Activities and Alternatives for Enhancement



Report by the
NOS Nutrient Pollution Synergy Team
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NUTRIENT POLLUTION: Current National Ocean Service Activities and Alternatives for Enhancement

I. The Problem

Nutrient pollution refers to excessive amounts of nutrients (primarily nitrogen and phosphorus) entering streams, rivers, estuaries and coastal waters. The initial ecosystem response to nutrient pollution in these waterbodies is an increase in the growth of algae, often leading to other undesirable symptoms such as high turbidity, low dissolved oxygen, loss of submerged plants, and occurrences of nuisance and toxic algae blooms. Taken together, these symptoms are referred to as “eutrophication.” As a result of eutrophication, nutrient pollution can have dramatic impacts on fishery resources, local economies, and public health. Besides such immediate and recognizable impacts, eutrophication can also have long-term implications for ecosystem health, as food web dynamics are altered and shifts occur in species composition.

As early as the 1950s, it was recognized that nutrients from land-based human activities were causing water quality problems in coastal areas. More recently, it has become clear that these problems occur in nearly all of the 138 estuaries included in a study of these problems. However, for 17 of these estuaries, an evaluation cannot be made and for 32 estuaries identified as having some level of problems, the information and data is speculative and needs further quantification. In some watersheds, these problems are occurring with more frequency, longer duration, and greater severity as population density increases and agricultural production expands, leading to nutrient inputs far exceeding natural levels.

Several recent reports cite eutrophication as the most challenging pollution problem in coastal waters (see Table 1). NOAA’s National Estuarine Eutrophication Assessment predicts that by the year 2020, eutrophication symptoms will worsen in two thirds of the Nation’s estuaries if appropriate management actions are not implemented. Another recent report, entitled *“Technology and Information Needs of the Coastal and Estuarine Management Community,”* highlights three common key national coastal management issues: 1) nutrient overload, 2) pathogens and toxic contamination, and 3) habitat modification and loss. Nutrient enrichment and habitat were identified as high priority issues in all regions except the Pacific, where pathogens and toxic contamination were seen as a higher priority.

Symptoms of Nutrient Enrichment and Eutrophication

- Higher nutrients loads from land-based activities lead to increased production of algae in the receiving waters. High concentrations of algae in the water column increase turbidity in these waters, reducing sunlight that reaches rooted aquatic plants and benthic algae.
- Higher nutrients lead to increased growth of epiphytes, phytoplankton that grow on the surface of seagrass leaves, blocking sunlight and interfering with plant respiration. In addition to light blocked out by higher turbidity, epiphytes can cause dieoff of seagrasses resulting in a loss of fishery habitat.
- Eutrophication can result in a shift in species in the microflora of estuarine and coastal ecosystems, typically favoring flagellated forms over diatoms, which are generally considered to have greater nutritional value to organisms that feed on them (copepods, oysters, etc.). Such conditions may also favor toxin-producing species (Harmful Algal Blooms, Red Tides) that, when concentrated in shellfish, are a threat to human health.
- Nutrient pollution may shift the Nitrogen to Phosphorus ratio (N:P ratio) in estuarine waters. Such a shift may favor species considered “less desirable” to organisms that feed on them, thereby affecting the food chain with potential losses to recreational and commercial fisheries.
- When high concentrations of algae die and decay, it leads to reduced oxygen (hypoxia and anoxia) in bottom waters. Hypoxia/anoxia leads to displacement of mobile species away from low oxygen areas (restriction of available habitat) and stress or death to those organisms that can not escape hypoxic/anoxic waters.

Table 1: Reports illustrating serious threats to coastal waters from eutrophication (associated with nutrient pollution).

YEAR	REPORT TITLE	AUTHOR(S)/PUBLISHER
1954	<i>The Ecology of phytoplankton blooms in Moriches Bay and Great South Bay, Long Island, New York</i>	J.H. Ryther in Biological Bulletin
1965	<i>Nitrogen, Phosphorus and Eutrophication in the Coastal Marine Environment</i>	J.H. Ryther and W.M. Dunstan in Science
1969	<i>Eutrophication: Causes, Consequences, Correctives</i>	National Academy of Sciences
1981	<i>Estuaries and Nutrients</i>	B.J. Neilson and L.E. Cronin (eds)
1993	<i>Managing Wastewater in Coastal Urban Areas</i>	National Academy of Sciences
1994	<i>Priorities for Coastal Ecosystem Science</i>	National Academy of Sciences
1996	<i>Journal Estuaries – special issue: Nutrients in Coastal Waters</i>	S.B. Bricker & J.C. Stevenson (eds)
1999	<i>National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries</i>	S.B. Bricker, C.G. Clement, D.E. Pirhalla, S.P. Orlando, D.R.G. Farrow
1999	<i>Technology and Information Needs of the Coastal and Estuarine Management Community</i>	A. Frankic, Coastal States Organization
2000	<i>Causes and Management of Eutrophication</i>	National Academy of Sciences
2000	<i>Integrated Assessment of Hypoxia in the Northern Gulf of Mexico</i>	Committee on the Environment and Natural Resources

II. Why NOS is involved in Nutrient Pollution issues

As the Nation's principal agency for coastal and ocean stewardship, the National Ocean Service (NOS) has a particular interest in nutrient pollution issues. Specifically, NOS has a unique role to play with respect to:

- Coastal Ecosystem Health and Habitat
- Coastal Management
- Trust and stewardship responsibilities for coastal resources, including marine sanctuaries

NOS conducts several programs and activities designed to understand, assess and monitor water quality conditions related to nutrient pollution. NOS also has a role in managing the activities that generate nutrient pollution. The NOS vision and mission provide direction for these roles.

NOS is responsible for implementing several legislative mandates related to nutrient pollution and eutrophication. In addition, the agency responds to initiatives of the Administration and other inter-agency activities. The following represent the foundation for NOS involvement in nutrient pollution issues:

NOS Vision

Individuals and institutions have the tools and information necessary to preserve, protect, and develop the environmental well-being and economic prosperity of the Nation's coastal and ocean resources for this and future generations.

NOS Mission

To support and provide the science, information, management, and leadership necessary to balance the environmental and economic well-being of the Nation's coastal resources and communities.

The NOS Strategic Plan includes a number of related goals and objectives. For example:

NOS Goal for Habitat: Enhance the preservation and restoration of the U.S. coastal and ocean environments.

Objectives:

- Increase capabilities, infrastructure, and the role of ecosystem science to reduce the cumulative degradation of coastal habitats and to protect and restore coastal ecosystems.
- Improve capabilities and infrastructure to reduce the pollution of coastal waters, improve water quality and enhance beneficial uses.

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- *The Harmful Algal Bloom and Hypoxia Research and Control Act of 1998 (HABHRCA)* - authorizes NOAA, through its ongoing research, education, grant, and coastal resource programs, to support a near and long-term comprehensive effort to prevent, reduce, and control HABs and hypoxia. These phenomena are believed to be linked to nutrient pollution. NOS is the lead agency for this interagency effort.
 - *Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990* - requires states with approved coastal zone management programs to develop and implement coastal nonpoint pollution control programs. These programs will implement management measures to prevent and reduce nonpoint source (runoff) pollution, including nutrient pollution. NOS administers this program jointly with EPA.
 - *Marine Protection, Research, and Sanctuaries Act (MPRSA), Title II, Ocean Dumping of 1972 (as amended)* - provides for the establishment of monitoring and research programs on the effects of dumping into ocean waters, including the possible long-term effects of pollution, overfishing and human-induced changes in ocean ecosystems. NOS conducts ongoing research that addresses these issues.
 - *The National Marine Sanctuaries Act of 1992, as amended (Title III of the MPRSA)* – establishes management responsibility for NOAA to accomplish comprehensive and coordinated conservation and management of designated marine protected areas, including activities affecting those areas (such as nutrient pollution). NOS has stewardship responsibility for 12 National Marine Sanctuaries.
 - *National Coastal Monitoring Act of 1992 (Title V of the MPRSA)* - establishes a national coastal water quality monitoring program. It directs EPA and NOAA jointly to implement a long-term program to collect and analyze scientific data on the environmental quality of coastal ecosystems, including ambient water quality, health and quality of living resources, sources of environmental degradation, and data on trends. The National Coastal Monitoring Act included authorizations for appropriations through fiscal year 1996, but funds have never been appropriated.
 - *Clinton Administration Clean Water Action Plan (Feb. 1998)* - includes several key actions that are designed to reduce excess nutrient loading. NOS is the co-lead for the Coastal Protection and Polluted Runoff Action Team and for developing a comprehensive Coastal Research and Monitoring Strategy.
 - *Report Card on the Nation's Ecosystems (began 1997)*- provides opportunities to design mechanisms and develop key indicators to assess the status and trends of the Nation's ecosystems. NOS is the lead agency for the coastal and marine ecosystem portion of this initiative.
 - *The Committee on the Environment and Natural Resources (CENR) and the National Ocean Partnership Program (NOPP)* – are national level inter-agency efforts that establish coordinated, integrated monitoring and assessment programs. NOPP is developing the Global Ocean Observing System (GOOS) and supports several coastal ocean oceanographic forecasting systems. CENR has developed the Integrated Science for Ecosystem Challenges (ISEC) which calls for a science plan for Harmful Algal Blooms and hypoxia.
 - *National Estuarine Research Reserves (NERR) System-wide Monitoring Program (SWMP)* - an initiative to support monitoring that will allow a more direct cause and effect linkage of non-point source pollution and habitat change. SWMP is collecting continuous water quality information at 25 reserves around the Nation. When combined with habitat change and nutrient measurements, the data will provide trends information about eutrophication and environmental stress in estuaries. NOS works in partnership with coastal states to manage the SWMP, including dissemination of collected data.
- In order to fully understanding the NOS role in addressing nutrient pollution issues, it is important to view that role in the context of other agency programs and activities. For example, the U.S. Environmental Protection Agency serves as the Nation's primary regulatory agency for protecting the public from significant health and environmental risks and to safeguard the natural environment, including control of nutrient pollution. Programs to manage nutrient inputs from agricultural activities are the domain of the U.S. Department of Agriculture. The U.S. Geological Survey is responsible for monitoring and assessing the Nation's surface and ground water, including assessment of water quality and pollution in rivers and estuaries. The U.S. Army
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Corps of Engineers plays a significant role in construction of port facilities and other civil works projects in bays and estuaries, and for assessing the impacts (including changes in water quality) of their work.

NOS works in partnership with these and other agencies, including state and local governments and non-government organizations, to play its appropriate role in addressing nutrient pollution. However, the NOS role differs from other agency roles in the following ways:

1. **As a coastal steward, NOS has direct management and trust responsibilities for marine protected areas and coastal environments, including assessment of and solutions to pollution threats, as opposed to relying only on states and other partners to implement activities.**
2. **NOS has a responsibility to provide a national picture of ecosystem health for the coast, and to foster healthy coastal ecosystems, as opposed to inland areas and other parts of the country.**
3. **NOS is focused on coastal stewardship as it relates to healthy coastal ecosystems, including estuarine, coastal and marine fisheries, as opposed to environmental impacts on human health or soil productivity.**

III. How NOS currently addresses Nutrient Pollution Issues

Growing out of the NOS mission and ongoing legislative mandates and programmatic roles, NOS is currently involved in a number of activities related to nutrient pollution. Described below are the principal activity areas focused on nutrient pollution and associated NOS offices and programs. The list is not exhaustive, but rather is intended to illustrate the primary roles and responsibilities of various NOS line offices. Illustrative examples follow the description of program office roles.

RESEARCH

National Centers for Coastal Ocean Science (NCCOS) – primarily regional or site-specific research on particular nutrient issues.

- Assessing the effects of nutrient discharge in the coastal waters of the United States, especially the effects of the Mississippi River outflow.

- Determining the role of critical micro-nutrients in primary productivity and water column eutrophication.
- Developing remote sensing applications for monitoring coastal water properties, including chlorophyll, water clarity, sediment plumes, harmful algal blooms, and ocean features related to productivity.
- Developing new bio-indicators to assess ecosystem health.

Office of Ocean and Coastal Resource Management (OCRM) – primarily site-specific research at individual sites of the National Estuarine Research Reserve System (NERRS).

- Researching the causes and effects of nutrient pollution and potential solutions at specific estuarine reserves.

MONITORING

NCCOS – primarily large scale and regional monitoring and tool development — the National Status and Trends Program collects data on a variety of parameters, including the history of nutrient pollution from sediment core analyses.

- Using remote sensing applications for monitoring coastal water properties, including chlorophyll, water clarity, sediment plumes, harmful algal blooms, and ocean features related to productivity.
- Harmful Algal Bloom (HAB) monitoring in Maryland, North Carolina and Florida.

Coastal Services Center (CSC) – primarily remote sensing.

- Utilize remotely sensed imagery to characterize and analyze changes in land cover in coastal areas for among other things, interpretation of the effects of land cover on the origins of nutrient pollution (with NCCOS).
- Utilizing near-real time and retrospective remote sensing data sets to develop a prediction and monitoring system for harmful algal blooms in the eastern Gulf of Mexico.

OCRM (including the National Estuarine Research Reserve System [NERRS], Cooperative Institute for Coastal and Estuarine Environmental Technology [CICEET] and National Marine Sanctuaries) – monitoring water quality parameters in estuarine reserves and marine sanctuaries and developing new technologies.

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- The NERRS System-wide water quality monitoring program collects real-time data on a variety of water quality parameters, including water temperature, specific conductivity, salinity, dissolved oxygen, depth, pH and turbidity.
 - Improving technology and techniques to better collect and analyze environmental data through CICEET research and development.
 - Nutrient monitoring in the Florida Keys National Marine Sanctuary.

Center for Operational-Oceanographic Products and Services (CO-OPS) – monitors water levels and water currents and other physical and chemical parameters.

- The National Water Level Observation Network (NWLON) has been primarily a nation-wide long-term monitoring effort for water levels and associated products and the historical data base has considerable sea surface water temperature and density data.

ASSESSMENT/MODELING

Special Projects Office (SPO) – assessing the extent of eutrophication in the Nation's estuaries, including eutrophication caused by nutrient pollution.

- Assessing the scale, scope, and characteristics of nutrient enrichment and eutrophication in the nation's major estuaries, including the severity of the problem, the extent to which the problem can be controlled or prevented, and how resources can best be applied to reduce impacts and prevent future eutrophication problems.
- The Estuarine Susceptibility Index evaluates the susceptibility of an estuary to nutrient-related water quality problems using physical transport properties, primarily the capacity of the water column and the flushing/retention time.
- Watershed modeling of runoff, total suspended solids and nitrogen and phosphorus inputs using the Sediment and Water Assessment Tool (SWAT); a hydrologic model designed to estimate nonpoint source loadings of water, sediment and nutrients from different land use types. Though the application of the model is currently suspended due to resource constraints, it has been used for estimation of nonpoint loadings from coastal watersheds, including the Gulf of Mexico and Gulf of Maine.

NCCOS – assessing the impacts of anoxia, hypoxia,

and harmful algal blooms, including those believed to be linked to nutrient pollution.

- Assessing the ecological and economic consequences of harmful algal blooms, alternatives for reducing, mitigating, and controlling harmful algal blooms, and the social and economic costs and benefits of the alternatives.
- Assessing the ecological and economic consequences of hypoxia, alternatives for reducing, mitigating, and controlling hypoxia, and the social and economic costs and benefits of the alternatives. Special emphasis on the Gulf of Mexico (with **SPO**).

CSC – developing geographic information system (GIS) tools that can be used to assess nutrient pollution potential.

- Developing an integrated GIS that includes land cover, elevation, and water quality data for marine protected areas.

OCS – The Coast Survey Development Lab has developed a suite of hydrodynamic models that can be used to better understand the circulation, flushing, and retention characteristics of contaminants for estuaries and coastal regions.

- Nowcast/forecast model systems will be adapted to the problem of harmful algal bloom landfall prediction.
- A hydrodynamic circulation model of the waters surrounding the Hawaiian Islands was developed as part of the effort to discover the cause and transport of macro-algal blooms that posed a nuisance to beaches in Maui.

OCRM/CICEET - developing, testing and applying novel predictive models for understanding and forecasting the impacts of pollution and contaminants on estuarine systems.

- The Development of an Estuarine Status and Forecast System: the modeling component.

Office of Response and Restoration (OR&R) – development and use of trajectory models for oil spill tracking that can also be used to trace impacts of harmful algal blooms.

MANAGEMENT

OCRM – Management responsibility for the Nation’s coastal zone (in partnership with coastal states), NERRS, and National Marine Sanctuaries.

- Working with coastal states to implement coastal nonpoint pollution control programs.
- Managing estuarine research reserves and national marine sanctuaries through site characterization, identification of nutrient pollution threats and impacts, and implementation of management actions to protect water quality.

RESPONSE

NCCOS – responsibility and response capability for ecological events, including HAB outbreaks and other events caused by nutrient pollution.

- Implementing a national interagency harmful algal bloom response plan that addresses the issues associated with managing for reductions of these events (occurrence frequency and duration).
- Implementing the NOS response plan to address ecological consequences of extreme events including harmful algal blooms. (with **OR&R**)

EDUCATION, OUTREACH, AND COMMUNICATION

CSC – training services and conference support.

- Providing training workshops and conferences on topics related to nutrient pollution.

International Programs Office (IPO) – links with

other nations and foreign governments.

- Facilitating the exchange of information relating to nutrient pollution in international forums.

OCRM/NERRS – Networks through states and sites providing a means to disseminate information.

- Sponsoring coastal decision maker workshops on runoff pollution issues, providing states with fact sheets and sources of information on nutrient pollution, participating in Clean Water Action Plan activities, and using Sustainable Seas expeditions to raise awareness.

In addition to the programs and activities described above, NOS has additional capabilities in a number of areas that could be applied to nutrient pollution. For example, the Center for Operational Oceanographic Products and Services has existing water level and water current stations for collecting information on tides and currents, located in major ports around the Nation. New technology gauges have been accumulating water temperature data at most stations since 1992 and are capable of integrating other sensors such as salinity, pH, dissolved oxygen, etc., into the sensor suites for routine hourly transmission over a Geostationary Operational Environmental Satellite (GOES) from any of the stations. The Physical Oceanographic Real-Time System (PORTS) program has also been accumulating water current, meteorology and conductivity, temperature, density data from focused areas in several ports around the country for the past few years. Although primarily focused on real-time navigation products, PORTS sensor suites can also be modified to be more focused on nutrient pollution monitoring. Other parts of NOS and NOAA have capabilities for hydrologic and

Table 2: NOS program focus on nutrient pollution.

Principal Activity	Research	Monitoring (includes remote sensing)	Assessment/ Modeling	Management	Response	Education/ Outreach
Program Office						
NCCOS	■	■	■		■	
OCRM	▣	■	▣	■		▣
CSC		■	▣			▣
OCS		▣	■			
SPO			■			
ORR					■	
IPO						▣
CO-OPS		■				

■ = significant activity for this office

▣ = limited activity for this office

atmospheric modeling that could be brought to bear in further understanding and managing nutrient pollution. Table 2 provides a general indication of NOS program office focus with respect to nutrient pollution.

IV. Gaps in the current NOS approach to Nutrient Pollution

Though NOS has many programs and activities that are either directly or indirectly related to nutrient issues and eutrophication, there is currently not a coherent, comprehensive program to direct NOS efforts and investments for nutrient pollution. The following represent some of the key challenges to developing a more integrated approach to the way NOS currently addresses nutrient pollution issues, including some specific examples:

1. **Lack of an integrated NOS strategy for addressing Nutrient Pollution** – NOS does not have a strategy to coordinate and integrate activities to address nutrient pollution in a cohesive and comprehensive manner. While there is much work being done among NOS offices regarding various aspects of the nutrient pollution issue, there is no overall design or plan to direct the activities of separate program offices towards a unified nutrient pollution objective.
 - Activities of individual program offices are directed by separate annual operating plans, budget initiatives, and assigned priorities.
2. **Lack of coordination between and among NOS Program Offices** – There is little in the way of a forcing function to ensure that program offices closely coordinate their activities related to nutrient pollution. In particular, there is a limited amount of coordination across program lines to address nutrient pollution in a systematic way – different parts of NOS are involved in different programs, arising from different purposes.
 - Processes within NOS program offices have not been designed to ensure coordination between research and monitoring programs. For example, NCCOS, SPO, OCRM, and OCS all have activities related to environmental modeling, however they are not closely coordinated. In addition, several offices are

working on GIS and related database/tool development in isolation from each other.

- NOS budgeting processes and congressional appropriations for particular programs tend to preclude pooling of resources to address issues such as nutrient pollution, which transcend any one program's capabilities.
 - The Marine Sanctuaries and Estuarine Reserves Programs do not monitor for the same parameters, precluding comparison of results at a national level.
3. **Insufficient data collection and monitoring for nutrients**– In essence, NOS does not monitor comprehensively for nutrient pollution. While there is some monitoring for nutrients associated with research, most NOS monitoring focuses on data collection for physical parameters (e.g., temperature, salinity) and toxic contaminants, providing insufficient information for fully understanding nutrient pollution¹. In addition, program offices operate at a variety of geographic scales, including national, regional, state and local. Temporal scales for program activities vary from real time to months to years to decades.
 - NS&T monitors for inorganic and organic pollutants but does not measure nutrients or nutrient related impacts (e.g. nutrients, dissolved oxygen, chlorophyll a).
 - Data collected for research may have application only in the particular coastal watershed where the project is being conducted.
 - Monitoring within the NERRS is conducted at two discrete points within each of the Reserves on a continuous basis. Monitoring of HABs is for discrete time periods and select watersheds. NS&T monitors on a national basis at 2 – 10 year sampling frequencies.
 - Data collected from the NWLON and PORTS programs have traditionally been focused on promoting safe navigation products and storm surge.
 4. **Limited application of scientific findings and research to management needs** - there is a weak linkage between research on symptoms of nutrient pollution and the management programs that NOS uses to reduce nutrient pollution. NOS does not have a significant effort dedicated to measure the success of management strategies that have been implemented.

¹See Coastal Environmental Monitoring Committee Report 1: "Current and Planned NOS Environmental Monitoring Activities"

- Research on the causes and consequences of harmful algal blooms is not tied to the management efforts of coastal states to prevent and reduce polluted runoff through the Coastal Nonpoint Pollution Control Program.
- Success of management efforts to control nutrient pollution through coastal management efforts is not evaluated as part of the monitoring and assessment activities of NOS.
- Research into the processes of restoration and the management efforts required to restore habitats damaged by nutrient pollution are not emphasized.

- 5. Insufficient coordination with other agencies and universities** - Other agencies such as EPA, the U.S. Geological Survey and Army Corps of Engineers and universities have been conducting programs and studies on various aspects of nutrient pollution. These ongoing activities could be used in combination with ongoing and new NOS initiatives to provide a comprehensive nutrient pollution picture for the Nation, with NOS as the leader in collecting, interpreting and disseminating information.

V. Recommended Actions to Fill Gaps and Enhance the NOS role in Nutrient Pollution

The NOS Nutrient Pollution Synergy Team has examined some of the current institutional barriers and programmatic constraints to fully realizing the potential of NOS to address nutrient pollution issues. The following represents a list of possible alternatives for the NOS Senior Management Council (SMC) to consider in designing a more effective strategy for nutrient pollution. It is important to note that some of these alternatives are related to current NOS investment proposals and coordination efforts, including the habitat proposal for developing a Coastal Observation, Assessment and Forecasting Service (COAFS) and the efforts of the Coastal Environmental Monitoring Committee (CEMC) to design a coordinated coastal monitoring strategy.

1. Develop a strategy for assessing and addressing Nutrient Pollution in coastal waters

NOS has recently developed strategies for coordinating activities in a number of areas, including hazards response and dredging. In addition, the CEMC is currently working to develop and present final recommendations for an integrated NOS Environmental Monitoring Plan. A similar strategy could be

developed for NOS activities related to nutrient pollution and eutrophication, with appropriate cross connections and integration with the monitoring strategy and other NOS coordination efforts. Such a strategy could:

- More clearly articulate the roles and responsibilities of NOS Program Offices for nutrient pollution and eutrophication, drawing on the general descriptions provided in this paper.
- Provide a mechanism for more closely coordinating program activities between offices related to nutrient pollution. For example, the existing Nutrient Pollution Synergy Team could be given a greater role in coordinating and influencing how NOS addresses nutrient pollution issues, with guidance from the SMC.
- Provide clearer direction with respect to collaboration and coordination with other Federal agencies, states and other interests, establishing the vision for the NOS role in nutrient pollution issues now and in the future.

2. Improve coordination and build on existing capabilities among NOS Offices

NOS could further coordinate and expand on these capabilities by:

- Implementing a review function to ensure better coordination among offices that are doing complementary or overlapping work – for example, forming intra-NOS committees and workgroups to coordinate monitoring, modeling, and GIS development.
- Encourage cooperation and collaboration with crosscutting funding mechanisms.
- Establishing a collaborative process for evaluating program activities related to nutrient pollution and sharing information between programs that can be mutually supportive. This could be designed as part of the strategy development described above.
- Conducting Special Watershed Assessments to highlight and test NOS capabilities and interoffice integration of those capabilities in a few representative areas.
- Adapting OCS nowcast / forecast models to address the problem of harmful algal bloom landfall prediction.

3. Develop an integrated framework for nutrient monitoring

The CEMC has conducted an inventory of existing NOS monitoring efforts and prepared a draft report entitled “Current and Planned NOS Environmental Monitoring Activities” (February 2000). While NOS has a number of monitoring programs, they are not designed to provide a complete national picture of the extent of or trends in nutrient pollution in coastal waters. NOS could improve its ability to monitor nutrient pollution by:

- Developing standards and protocols for all NOS programs and partners to ensure comparability at regional and national scales.
- Developing a list of nutrient related parameters to measure for appropriate time and spatial scales for monitoring these parameters to assess and track nutrient related water quality impacts. As part of the CEMC’s Monitoring Strategy, NOS will need to determine whether such monitoring should be conducted by NOS, in collaboration with other Federal agency monitoring efforts, or through capacity building in states or other entities or combinations of both.
- More closely coordinating a number of data collection activities to ensure consistency of monitored parameters and timeframes, including a national system for reporting on the health of coastal waters.
- Focusing monitoring efforts to specifically track the progress of water quality over time in estuaries where management actions have been implemented, providing useful information and feedback to the management community.
- Examining the NWLON and PORTS programs for potential enhancements that could utilize these existing long-term monitoring efforts to meet objectives of nutrient pollution monitoring. For example, NWLON and PORTS sensor suites could easily be enhanced to include long-term measurements of parameters focused towards nutrient pollution monitoring in real-time and near real-time.
- Supporting the Coastal Observation Assessment and Forecasting Service (COAFS) proposal for predictive capabilities and forecasting. This initiative for 2002 is designed to emphasize forecasting for eutrophication in the first few years of the program.
- Expanding coverage of C-CAP to include coastal land classification and change analysis, and work with NCCOS, NERRS, and local partners to examine relationships between changes in land use/land cover and water quality.

4. Improve research and assessment to support management

NOS needs consider how its research and assessment capabilities can be fully utilized to support management efforts. NOS has conducted a variety of coastal assessments for region-specific (e.g., Gulf of Mexico and Gulf of Maine) and national purposes (e.g., the National Estuarine Eutrophication Assessment). The Coastal Change Analysis Program (C-CAP) and Coastal Assessment and Data Synthesis System (CADS) also provide specific technical capabilities for conducting particular state-specific, regional or national assessments. State coastal management programs are addressing nutrient pollution as a part of the polluted runoff control activities. Specifically, NOS could improve the tie between scientific research, assessment and management by:

- Working with coastal states to further examine land use activities in coastal watersheds to assess the extent to which management measures for controlling polluted runoff have been implemented and are successful in reducing nutrient loads and nutrient related water quality problems.
- Integrating a number of sources of information and data (e.g., the National Eutrophication Survey, CADS, research findings, C-CAP, etc.) to provide a centralized and integrated source of information for coastal managers.
- Designing a process to more closely involve coastal resource managers in the planning and design of research activities to ensure that research is relevant for management needs while also ensuring that managers consider existing research results when selecting and implementing management options.
- Emphasizing research on the causes and linkages between nutrient inputs from watersheds and resultant water quality problems, leading to solutions on how to prevent future problems.
- Developing and refining existing models with assessment and predictive capabilities to provide guidance for implementation of management actions and/or information for redirecting unsuccessful actions.
- Expanding the Eutrophication Assessment to include other coastal states and territories (i.e.,

Great Lakes, Alaska, Caribbean and Pacific Islands) that were not part of the original assessment. At the same time, the existing assessment could be updated to include more recent data and information, using the Internet to support a more efficient and cost effective data collection tool. Finally, the assessment could be more fully integrated into other national (EPA 305(b) report) and state environmental assessment activities.

- Developing an Economic Impact Assessment Program. Although there are some site specific and event specific (i.e. impact of HAB blooms) estimates, there is still no comprehensive cost estimate of the impact of nutrients.

5. Improve and Expand Tools for Informing and Educating the Public

As described above, NOS conducts a number of program activities with nutrient pollution related components. However, there is currently not a framework or forum for organizing this information in a way that communicates to NOS constituents the full breadth and depth of NOS activities on nutrient pollution. Also, this information is often not translated in a way that makes it usable to a wider public audience. NOS could address these deficiencies by:

- Organizing a variety of program information (monitoring data, research, management program activities) under the central theme of nutrient pollution. This information could be distributed in a variety of media formats, but the growing capabilities of NOS to develop and disseminate information through the Internet could be a focal point.
- Taking advantage of outreach capabilities of state coastal management programs, NERRS, and Sea Grant in reaching target audiences.
- Working more closely with other Federal agencies that have roles in nutrient pollution, utilizing mechanisms such as the Clean Water Action Plan.
- Improving the translation and transfer of scientific data and information to the management community.
- Developing a forecasting capability to better inform resource managers and the public of impending nutrient related problems.

VI. Conclusion

NOS offices are currently doing a great deal with respect to nutrient pollution and eutrophication on an individual basis and there are encouraging signs of increasing cooperation and coordination among offices. However, by devising an integrated NOS approach to this important environmental problem, much more can be done to improve the delivery of NOS products and services to the coastal stewardship community. To fully realize this potential, NOS will need to make further investments to improve and augment existing efforts. In particular, development of budget initiatives for FY02 and FY03, including the Sustain Healthy Coasts Habitat and Coastal Monitoring/Observation initiatives, provide an opportunity to identify and further support areas where NOS could play a greater role in nutrient pollution.

Newspaper articles and press coverage, scientific journal articles, conference and meeting agendas make it abundantly clear – nutrient pollution is one of the hottest environmental topics of the day. Growing public awareness of how human and land-based activities lead to nutrient pollution impacts on coastal and ocean resources provides a unique opportunity for NOS to assert leadership on this issue. While other Federal agencies have related programs and, in some cases, significantly more resources to direct, NOS programs and activities span the full range of capabilities necessary to address the problem: scientific research and assessment to fully understand the causes and consequences of nutrient pollution; management programs for prevention and restoration; monitoring activities to gauge progress, and; communication tools to inform the public of our efforts. NOS needs to chart a course for future involvement in this area, building on existing strengths while further developing new potential.